EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	10981	VISIBLE ADJ WAVELENGTH	US-PGPUB; USPAT	OR	ON	2007/02/23 09:16
L3	1969	(VISIBLE ADJ WAVELENGTH) with "nm"	US-PGPUB; USPAT	OR	ON	2007/02/23 09:17
L4	1420	3 and @ad<"20031003"	US-PGPUB; USPAT	OR	ON	2007/02/23 09:32
L6	2	4 and (amorphous adj carbon)	US-PGPUB; USPAT	OR	ON	2007/02/23 09:23
L7	3	4 and (amorphous near3 carbon)	US-PGPUB; USPAT	OR	ON	2007/02/23 09:23
L8	1421	(amorphous near3 carbon) and anneal$3 and @ad<"20031003"	US-PGPUB; USPAT	OR	ON	2007/02/23 10:30
L9	236	((amorphous near3 carbon) same anneal$3) and @ad<"20031003"	US-PGPUB; USPAT	OR	ON	2007/02/23 09:33
L10	104	9 and wavelength	US-PGPUB; USPAT	OR	ON	2007/02/23 10:31
L11	1	("6214637").PN.	US-PGPUB; USPAT	OR	OFF	2007/02/23 10:17
L13	1	("7109087").PN.	US-PGPUB; USPAT	OR	OFF	2007/02/23 10:17
L15	20	(applied adj materials) and ((amorphous near3 carbon) same anneal$3) and @ad<"20031003"	US-PGPUB; USPAT	OR	ON	2007/02/23 10:30
L16	4	15 and wavelength	US-PGPUB; USPAT	OR	ON	2007/02/23 10:20
L17	2	(applied adj materials) and ((amorphous near3 carbon) same anneal$3)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/02/23 10:30
L18	1104	((amorphous near3 carbon) same (THERMAL OR THERMALLY)) and @ad<"20031003"	US-PGPUB; USPAT	OR	ON	2007/02/23 10:31
L19	500	((amorphous near3 carbon) WITH (THERMAL OR THERMALLY)) and @ad<"20031003"	US-PGPUB; USPAT	OR	ON	2007/02/23 10:31
L20	94	19 and wavelength	US-PGPUB; USPAT	OR	ON	2007/02/23 10:31

US-PAT-NO: 6423384

DOCUMENT-IDENTIFIER: US 6423384 B1

TITLE: HDP-CVD deposition of low dielectric constant amorphous carbon film

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Brief Summary Text - BSTX (11):

The sub-micron interconnect features in the next generation of ULSI integrated circuits also demand precisely patterned photoresist to properly etch the structures of the interconnect features into a dielectric film, such as an intermetal dielectric layer. Generally, to form an interconnect feature in a dielectric film on a substrate, a photoresist is applied over the surface of the dielectric film and patterned using a light source, preferably a light source using ultraviolet (UV) **wavelengths**. Typically, the UV light source uses **wavelengths** of about 193 nm or about 248 nm to pattern the photoresist for sub-micron features. After the photoresist has been patterned, the substrate is etched using commonly known etching techniques to form the interconnect structures in the dielectric film.

Brief Summary Text - BSTX (12):

An anti-reflective coating (ARC) is typically deposited on the dielectric film prior to the application of the photoresist. The ARC film reduces the reflections of the UV light source during the patterning process to provide sharper definitions to the patterns on the photoresist. However, currently practiced ARC films do not provide adequate anti-reflective properties for the 193 nm and 248 nm UV **wavelengths**. The patterns on the photoresist are distorted by the reflections of the UV light from the substrate surface, particularly reflection from the metal deposited on the substrate, resulting in poorly defined interconnect features after the etch process. Poorly defined interconnect features leads to improper and defective device formation on the substrate.

Brief Summary Text - BSTX (13):

Therefore, there is a need for a method of forming a hydrogenated amorphous carbon film that is useful in the fabrication of ULSI circuits. It would be preferable for the hydrogenated amorphous carbon film to possess a dielectric constant less than about 3.0 as well as exhibit high thermal stability at

temperatures greater than about 400.degree. C. It would be further desirable for the hydrogenated amorphous carbon film to provide low reflectance to UV light, particularly for the 193 nm and 248 nm UV **wavelengths** useful for patterning sub-micron interconnect features.

Brief Summary Text - BSTX (17):
In a preferred embodiment, the film is deposited using methane (CH.sub.4) and argon in a HDP-CVD reactor. The resulting low dielectric constant amorphous carbon film is thermally stable at temperatures of at least about 400.degree. C. and has a dielectric constant (k) of about 2.53. The amorphous carbon film formed according to the invention is useful for many applications in ultra large scale integration (ULSI) structures and devices, such as an inter-metal dielectric material. The amorphous carbon film formed according to the invention is also particularly useful as an anti-reflective coating to provide low reflectance to UV light, particularly for the 193 nm and 248 nm UV **wavelengths** useful for patterning sub-micron interconnect features.

Detailed Description Text - DETX (39):
The experiment was conducted using an Ultima.TM. HDP-CVD reactor available from Applied Materials, Inc. of Santa Clara, Calif. The substrate is a 200 mm substrate typically used in the semiconductor/integrated circuit production. The hydrocarbon gas, methane (CH.sub.4), is introduced into the chamber at a flow rate of about 125 sccm while the argon gas is introduced into the chamber at a flow rate of about 27 sccm. The chamber pressure during processing is maintained at about 15 mTorr. The source RF frequency for the source plasma generator was about 2.0 MHz while the bias plasma generator was inactivated during the deposition process. The source RF power applied to the chamber to generate and maintain the plasma was about 1000W. During processing, the substrate was maintained at a temperature of about 400.degree. C. A low dielectric constant **amorphous carbon** film was deposited by the reaction of methane under HDP-CVD plasma conditions. A low dielectric constant **amorphous carbon** film of about 5200 .ANG. thick was deposited using the above processing conditions. The substrate is then **annealed** in a nitrogen environment within the same chamber at about 400.degree. C. for about 30 minutes. The low dielectric constant **amorphous carbon** film has a thickness of about 4770 .ANG. after the **anneal**.

Detailed Description Text - DETX (40):
Table I and Table II list the depth profiles and the atomic concentrations of hydrogen, carbon, oxygen and silicon of the deposited film over the substrate before and after the **anneal** step, respectively. As shown in Table I, the low dielectric constant **amorphous carbon** film has a density of 1.23E23

atoms/cc with a hydrogen content ranging from 61.0% to 63.0% and a carbon content ranging from 37.0% to 39.0%. The surface of the film prior to **anneal** also includes oxygen content of 1.0% at a depth less than 700 .ANG.. After the **anneal,** as shown in Table II, the low dielectric constant **amorphous carbon** film has a density of 1.25E23 atoms/cc with a hydrogen content ranging from 69.5% to 70.0% and a carbon content ranging from 30.0% to 30.5%. The oxygen content is eliminated by the **anneal** step. Also, after the **anneal,** the resulting thickness of the low dielectric constant **amorphous carbon** film is reduced to 4770 .ANG.. The dielectric constant of the resulting film is about 2.53, and the film is thermally stable at a temperature of about 400.degree. C.

Detailed Description Text - DETX (43):

FIG. 3 is a graph showing the thermal stability of an **amorphous carbon** film deposited according to the invention. The graph shows the pressure measurements of eight different categories of gases as the deposited film is heated in an **anneal** chamber from room temperature to about 600.degree. C. to demonstrate the film's thermal stability. Thermal stability is represented by generally slight variations in the measured pressures for each category of gases while thermal instability of the film is indicated by sharp, significant rises (in logarithmic scale) in the chamber pressure that corresponds to breakdown and release of the category of gases into the chamber. In FIG. 3, the horizontal axis indicates the temperature of the film from 0.degree. C. to 600.degree. C., while the vertical axis indicates the pressure of different categories of gases in the chamber in logarithmic scale from 1.times.10.sup.-10 Torr to 1.times.10.sup.-5 Torr. The gases measured include CH.sub.3, H.sub.2 O, HF, CO, N.sub.2, SiH, CF, CO.sub.2, CF.sub.3 and SiF.sub.3. As shown in FIG. 3, the film is thermally stable to at least about 400.degree. C., as indicated by generally slight variations in the measured pressures. At temperatures greater than about 450.degree. C., most of the gases begin to desorb from the film, as indicated by the sharp rises in the pressure in the chamber, and the film becomes thermally unstable.

Detailed Description Text - DETX (45):

The inventors have discovered that a film formed according to the invention is also useful as an anti-reflective coating (ARC) to provide low reflectance to UV light used in patterning sub-micron interconnect features, particularly for the 193 nm and 248 nm UV **wavelengths**. In the process of forming interconnect structures in a dielectric layer on a substrate, the ARC film is deposited over the dielectric layer, and a photoresist is applied over the ARC film. The photoresist is then patterned using a UV light source, and the etching process is carried out to form the structures in the dielectric layer. As compared to currently practiced ARC films, the ARC film according to the

invention provides more precisely defined patterns on the photoresist because the ARC film according to the invention provides a lower reflectance to UV **wavelengths** of about 193 nm and about 248 nm. Because of the lower reflectance, the patterns on the photoresist are less distorted by the reflected UV radiation, resulting in sharper, more precisely defined patterns on the photoresist.

Detailed Description Text - DETX (46):

FIGS. 4a and 4b are graphs showing the reflectance of films deposited according to the invention used as anti-reflective coatings. The reflectance of the films represents a value as compared to the reflectance of bare silicon (i.e., reflectance of bare silicon equals one). The amorphous carbon film according to the invention provides low reflectance particularly for the 193 nm and 248 nm UV **wavelengths** that are used for patterning photoresist. The reflectance of the films deposited according to the invention varies with the **wavelength** of the radiation as well as the thickness of the films. The film measured in FIG. 4a has a film thickness of about 2561 .ANG. while the film measured in FIG. 4b has a film thickness of about 859 .ANG.. As shown in FIG. 4a, the reflectance of the film (2561 .ANG. thickness) is about 0.046 at **wavelength** of about 193 nm, about 0.005 at **wavelength** of about 248 nm, about 0.315 at **wavelength** of about 365 nm, and about 0.223 at **wavelength** of about 633 nm. As shown in FIG. 4b, the reflectance of the film (859 .ANG. thickness) is about 0.005 at **wavelength** of about 193 nm, about 0.228 at **wavelength** of about 248 nm, about 0.430 at **wavelength** of about 365 nm, and about 0.070 at **wavelength** of about 633 nm. Compared to currently practiced ARC films, the amorphous carbon film according to the invention provides significantly lower reflectance at these UV **wavelengths**. Both the composition and the thickness of the amorphous carbon film according to the invention can be adjusted to meet the reflectance demands of the photoresist patterning process for sub-micron structures.

Claims Text - CLTX (1):

1. A method for forming an anti-reflective coating on a substrate, comprising: a) positioning the substrate in a high density plasma chemical vapor deposition chamber; b) introducing a processing gas comprising a hydrocarbon gas and a carrier gas into the chamber, wherein the hydrocarbon gas is selected from the group consisting of alkene hydrocarbons, alkane hydrocarbons, alkyne hydrocarbons, and combinations thereof; c) generating a high density plasma of the processing gas; d) depositing an **amorphous carbon** film on the substrate while maintaining the substrate at a temperature of about 300.degree. C. to 400.degree. C.; and e) **annealing the amorphous carbon** film after deposition, wherein the **amorphous carbon** film is deposited on a

dielectric layer of a substrate, a photoresistive layer is applied to the **amorphous carbon** film, and the dielectric layer is etched to form an interconnect structure.

US-PAT-NO: 6815329

DOCUMENT-IDENTIFIER: US 6815329 B2

TITLE: Multilayer interconnect structure containing air gaps and method for making

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Brief Summary Text - BSTX (18):
It is an additional object of this invention to provide a method for forming multilayer interconnect structures containing voids, cavities or air gaps in the plane of one of more buried wiring levels, using Dual Damascene processing and an air gap defined initially by a solid sacrificial material which is subsequently removed by thermal decomposition to form a gas which is out-diffused or released through openings or removed by plasma, O.sub.2 microwave radiation or by radiant energy such as by ultra violet light or by a laser at a selected **wavelength**.

Detailed Description Text - DETX (18):
The sacrificial material 410 is then removed to form air gaps 130 as shown in FIG. 6K. Removal may be by one or more methods selected from the group consisting of thermal decomposition; thermal or non-thermal processes incorporating reactive chemical agents (e.g., O.sub.2), reactive plasma, and/or absorption of energetic electromagnetic radiation e.g., microwaves, ultraviolet light, a laser at a selected **wavelength**. Finally, those portions of the bridge layer not needed for the next level's via level dielectric are removed to form the structure of FIG. 6L. The processing is then repeated for as many air gap wiring levels as desired.

Detailed Description Text - DETX (24):
If removal of sacrificial material 410 is by thermal decomposition, the sacrificial material would preferably be thermally stable below a first temperature, and thermally unstable above a second temperature higher than the first temperature. Processing such as film deposition and patterning would typically be performed below this first temperature, which might be in the range from 60 to 200.degree. C. Note that if the temperature of sacrificial material deposition is substantially below this first temperature, **anneals** at temperatures at or slightly above this first temperature ma be performed to insure that the sacrificial material has sufficient compositional and

dimensional stability for process steps at or below this first temperature. For additional information with regard to dimensional and/or thermal stability of **carbon based amorphous** materials, reference is made to U.S. Ser. No. 08/916,011, filed Aug. 21, 1997, now U.S. Pat. No. 6,030,904, by A. Grill et al. entitled "Stabilization of Low-K Carbon Based Dielectrics" which is incorporated herein by reference. The sacrificial material would typically be removed by a process such a thermal decomposition at one or more temperatures above the second temperature, which might be in the range from 200 to 425.degree. C. Thermal decomposition above the second temperature would preferably produce easily dispersed volatiles and leave little residue. The sacrificial materials may be formed by various methods well known to those skilled in the art, including but not limited to: spinning from solution, spraying from solution, chemical vapor deposition (CVD), plasma enhanced CVD (PECVD), sputter-deposition, ion-beam deposition and evaporation.

Detailed Description Text - DETX (28):

The one or more layers of the bridge layer structure, shown as 480 and 490 in FIG. 6K, are preferably dielectric single or multiphase, and selected from the group consisting of silicon-containing materials such as amorphous hydrogenated silicon (a-Si:H), SiO.sub.2, Si.sub.3 N.sub.4, SiO.sub.x N.sub.y, SiC, SiCO, SiCOH, and SiCH compounds, these silicon-containing materials with some or all of the Si replaced by Ge, inorganic oxides, inorganic polymers, organic polymers such as polyimides, other carbon-containing materials, organo-inorganic materials such as spin-on glasses, diamond-like **carbon (DLC, also known as amorphous hydrogenated carbon,** a-C:H) with or without one or more additives selected from the group consisting of F, N, O, Si, Ge, metals and nonmetals. Additional choices for one or more of the bridge layer dielectrics include any of the aforementioned materials in porous form, as well as materials that may change during processing to or from porous and/or permeable forms. Treatments that may effect changes in film porosity/permeability include thermal **annealing** and/or irradiation by electromagnetic radiation such as ultraviolet light.